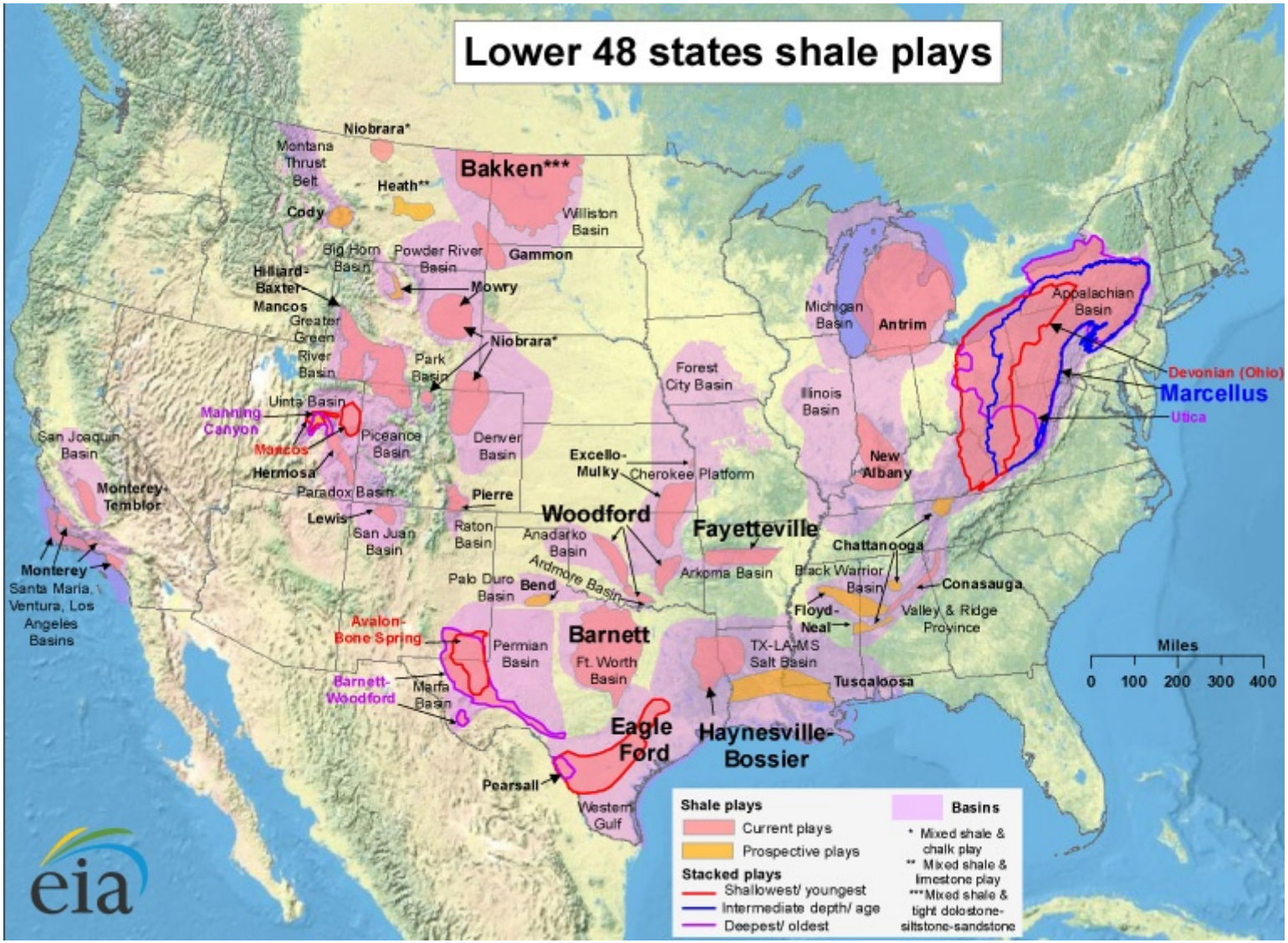
Unconventional Natural Gas Production: Environmental Overview

Mexico City Presentation

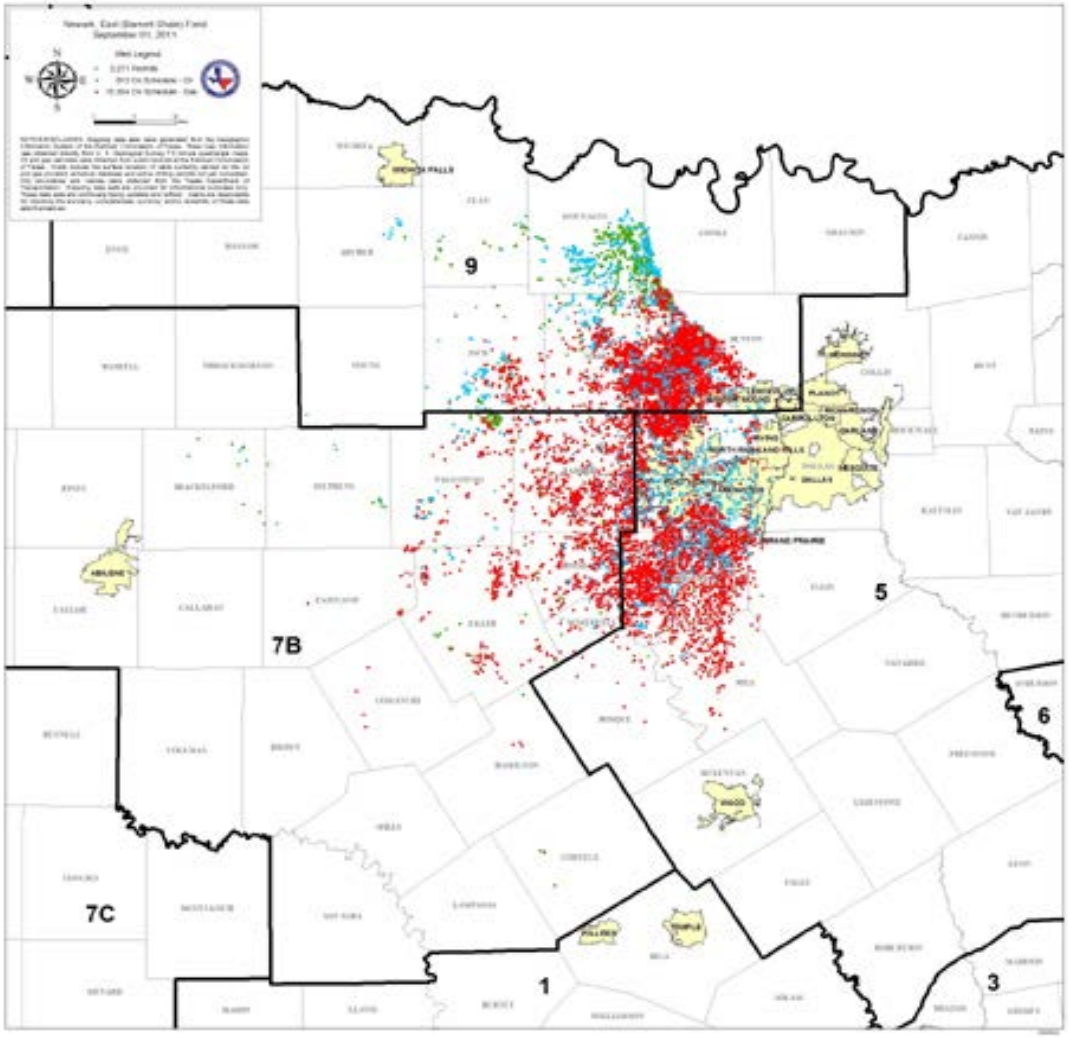
February 8, 2013

Levels of Government in the US

- There are 3 levels of government: Federal, State, and Local
- Native American Tribes maintain a special status and may apply to EPA for delegated regulatory authority to enact and enforce their own environmental ordinances
- Depending on the state, local governments (counties and cities) may have regulatory authorities under special use permitting or zoning requirements


Lower 48 states shale plays
Niobrara*
Montana Thrust Belt
Heath**
Bakken***
Williston Basin
Cody
Big Horn Basin
Powder River Basin
Gammon
Hilliard-Baxter-Mancos
Mowry
Greater Green River Basin
Niobrara*
Park Basin
Uinta Basin
Manning Canyon
Mancos
Hermosa
Piceance Basin
Denver Basin
Paradox Basin
Pierre
Lewis
San Joaquin Basin
Monterey-Temblor
Monterey
Santa Maria, Ventura, Los Angeles Basins
San Juan Basin
Raton Basin
Anadarko Basin
Woodford
Fayetteville
Ardmore Basin
Arkoma Basin
Palo Duro Basin
Bend
Avalon-Bone Spring
Permian Basin
Barnett
Ft. Worth Basin
Barnett-Woodford
Marfa Basin
Eagle Ford
Haynesville-Bossier
Pearsall
Western Gulf
Forest City Basin
Illinois Basin
Michigan Basin
Antrim
Appalachian Basin
Devonian (Ohio)
Marcellus
Utica
Excello-Mulky
Cherokee Platform
New Albany
Chattanooga
Black Warrior Basin
Conasauga
Floyd-Neal
Valley & Ridge Province
TX-LA-MS Salt Basin
Tuscaloosa
Miles
0 100 200 300 400
Shale plays
Current plays
Prospective plays
Stacked plays
Shallowest/ youngest
Intermediate depth/ age
Deepest/ oldest
Basins
* Mixed shale & chalk play
** Mixed shale & limestone play
*** Mixed shale & tight dolostone-siltstone-sandstone
eia

Drilling in the Barnett Shale Area



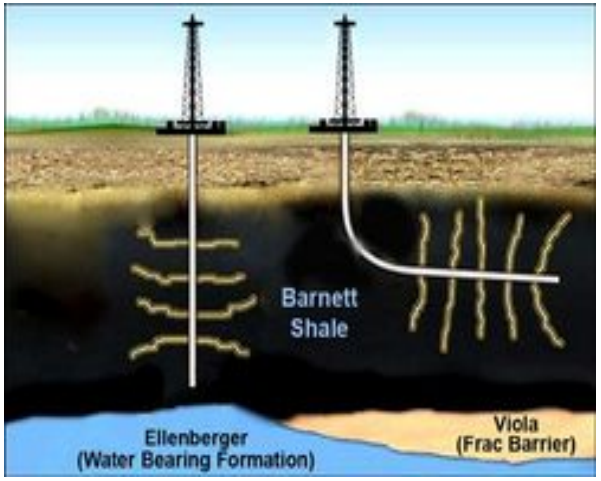
Extent of Operations in the Barnett Shale

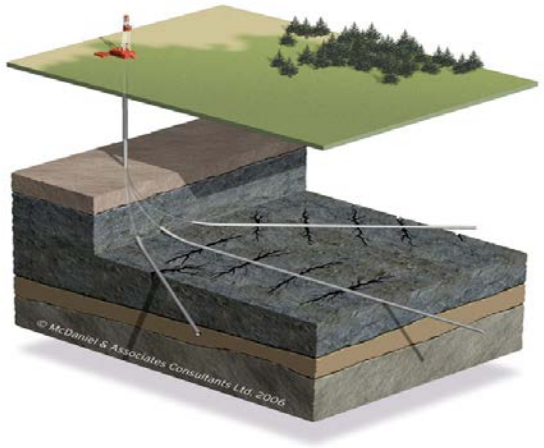
- There are over 16,346 wells drilled in the Barnett Shale area, within all or part of 24 counties in north central Texas.
- An additional 2,532 locations for wells have been approved by the Railroad Commission of Texas.
- There are 195 injection wells and commercial saltwater disposal wells.
- There are over 2750 stationary gas-fired engines in the Barnett Shale area.

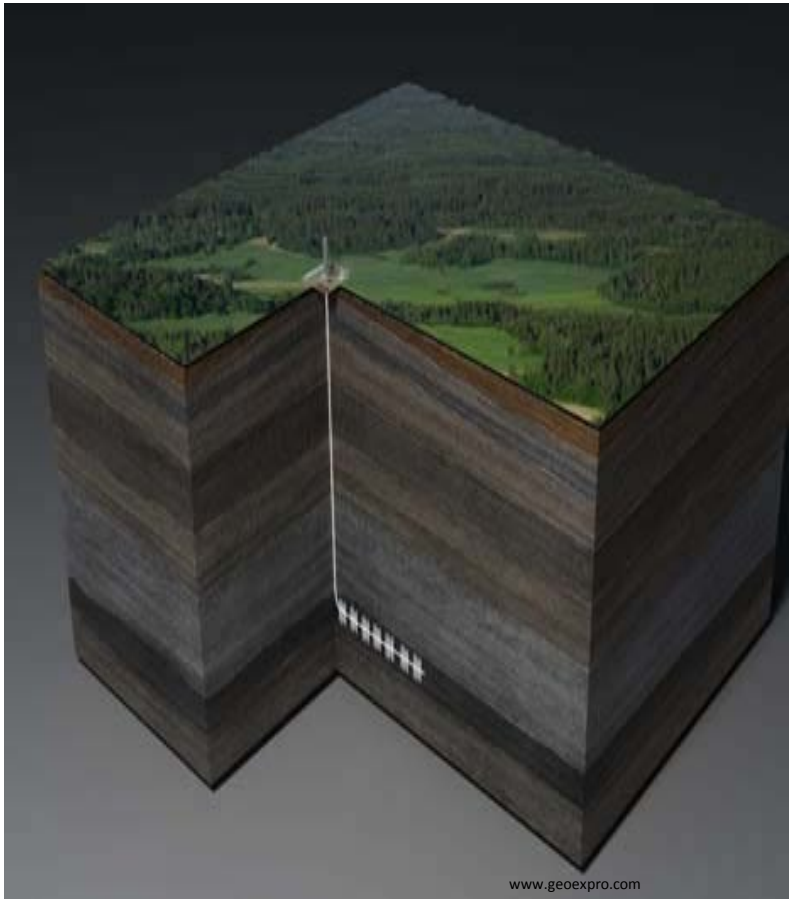
- Sources: Railroad Commission of Texas / Texas Commission on Environmental Quality

Unconventional Natural Gas Drilling

Often relies on horizontal drilling and hydraulic fracturing

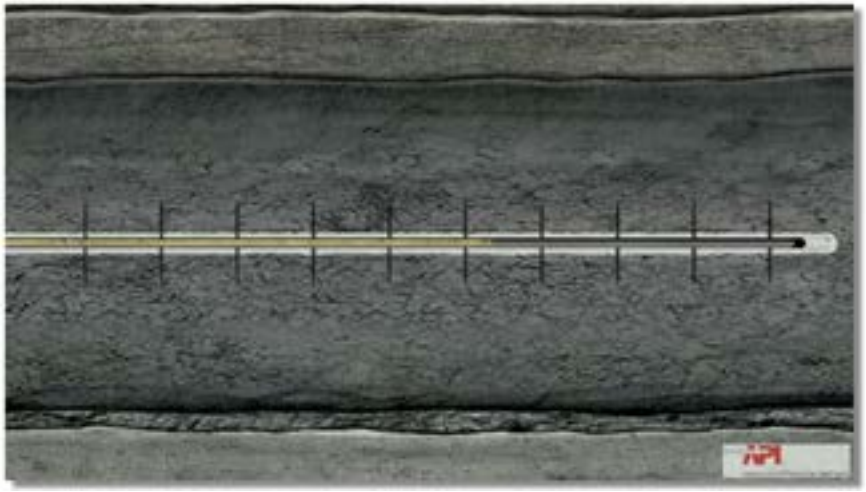






Unconventional Natural Gas Drilling: Hydraulic Fracturing

- Hydraulic fracturing (HF) is commonly used in the oil and gas industry to enhance subsurface fracture systems to allow oil or natural gas to move more freely from the rock pores to production wells.
- The goal of hydraulic fracturing is to improve the flow of fluids in oil and gas wells by connecting many pre-existing fractures and flow pathways in oil and gas containing rocks.
- Hydraulic fractures are created when a fluid is pumped down production wells at high pressure for short periods of time (hours).
- The high-pressure fluid exceeds the rock strength and fractures the rock.
- A propping agent, usually sand, is pumped into the fractures to keep them from closing when the fracturing pressure is released.

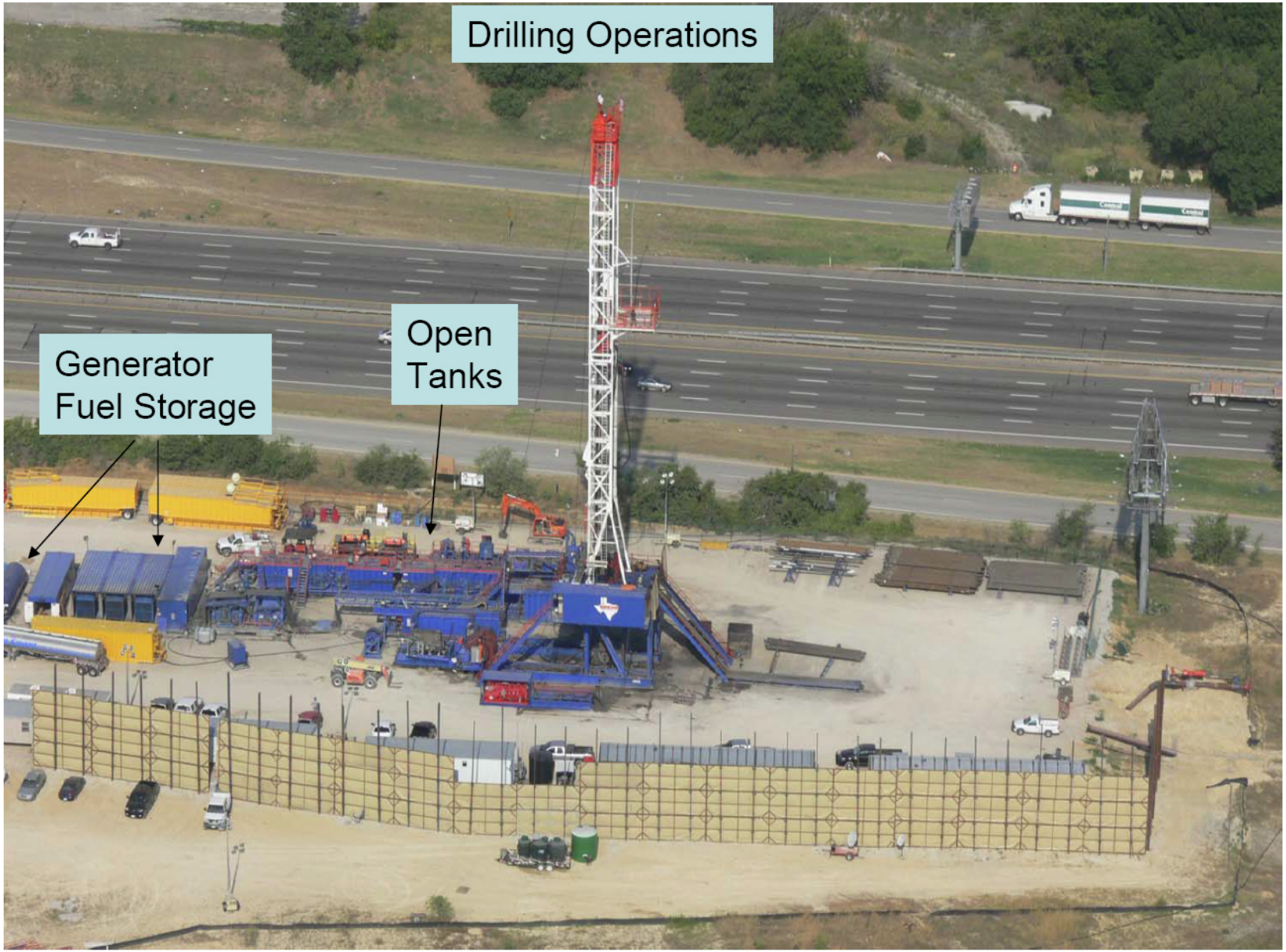


Unconventional Oil and Natural Gas Production: Potential Health Concerns

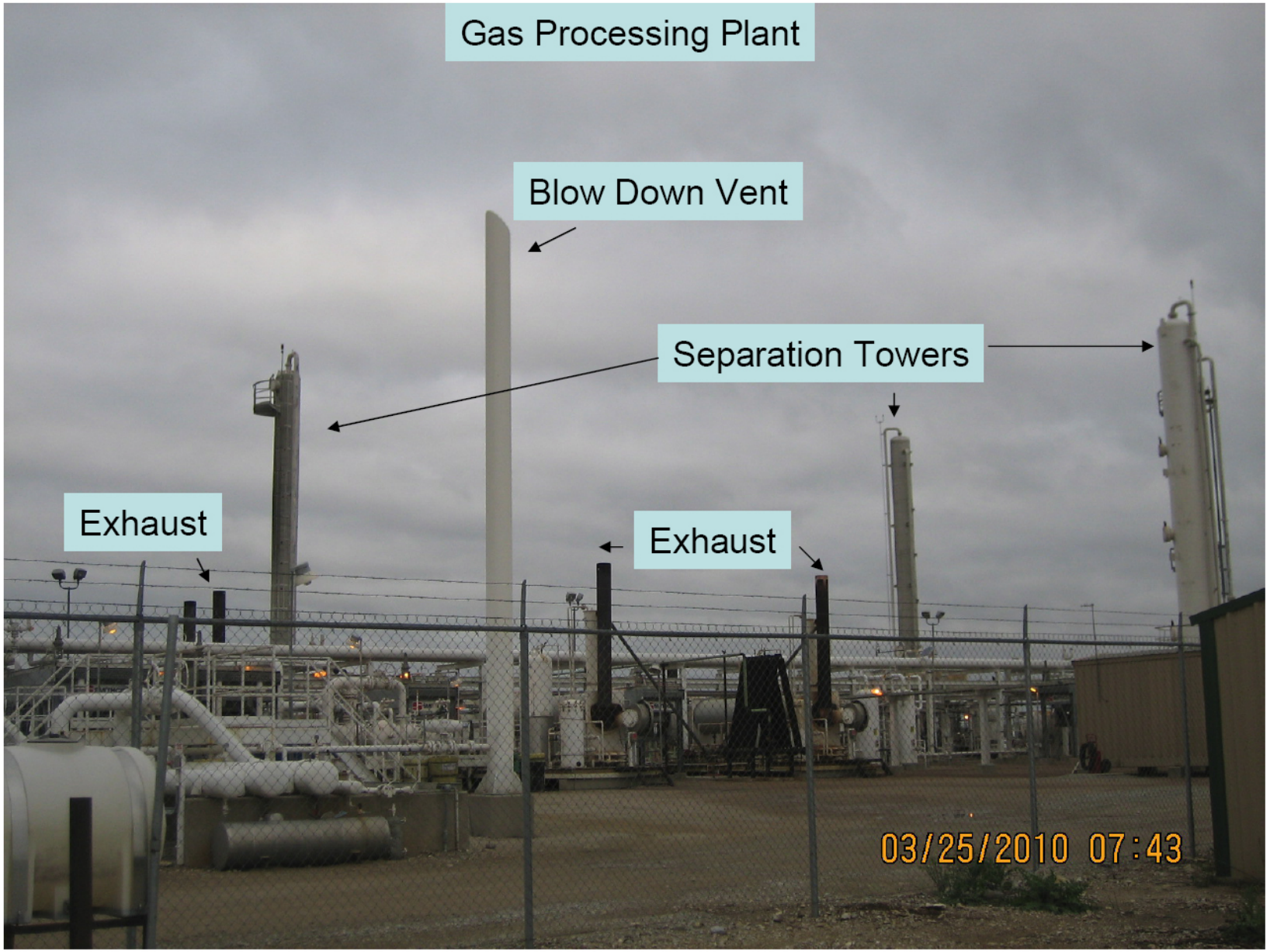
- VOCs are one of the key ingredients in forming ozone (smog).
  - The oil and gas industry is the largest industrial source of VOC emissions in the U.S., based on data reported to the 2008 National Emissions Inventory.
  - Ozone is linked to asthma attacks, hospital and emergency department visits, and increased school absences, among other serious health effects.
  - Ozone used to be considered a summertime pollutant; but recently has become a problem in winter in some areas where significant natural gas production occurs.
  - In some areas, VOCs also help form fine particle pollution ($PM2._5$).
- Air toxics can cause cancer and other serious, irreversible health effects, such as neurological problems and birth defects.
- Methane reacts in the air to form ground-level ozone and is a major Greenhouse Gas emission.

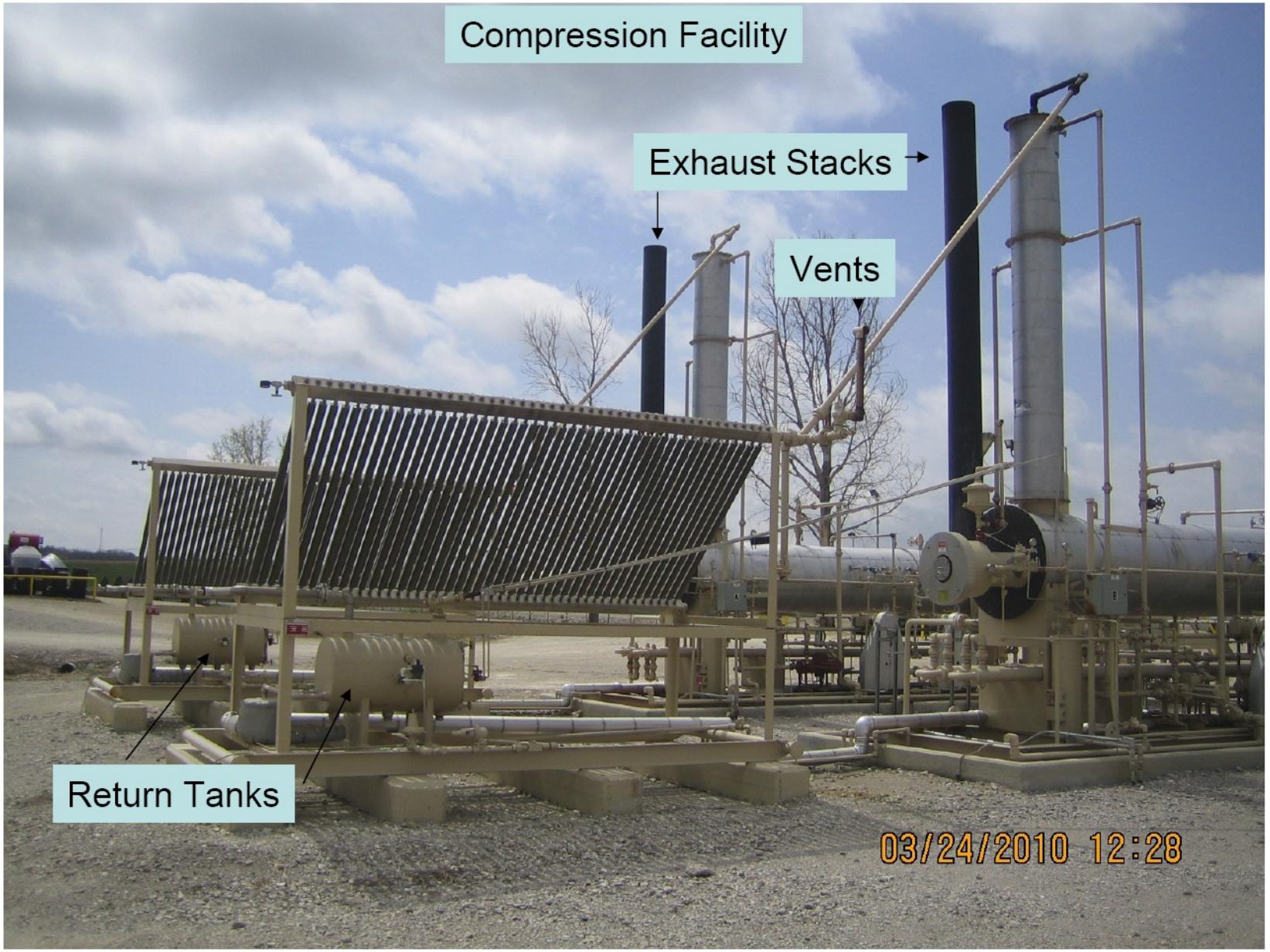
Source: 2008 NEI v2 http://www.epa.gov/ttn/chief/net/2008inventory.html

Aerial Photos of Fracturing Operations


Drilling Operations
Generator
Fuel Storage
Open
Tanks

Completion Operations

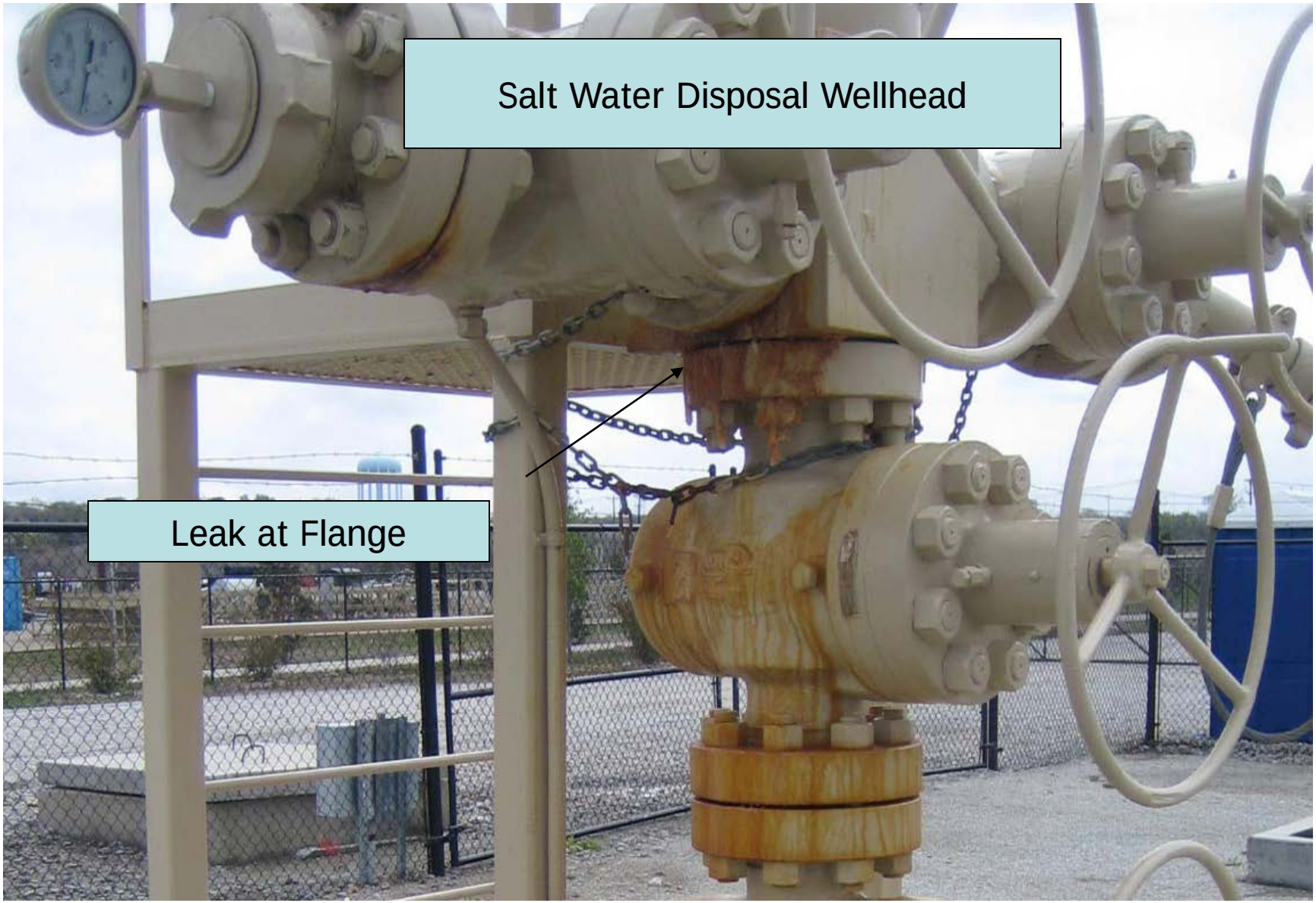

Gas Processing Plant
Blow Down Vent
Separation Towers
Exhaust
Exhaust
03/25/2010 07:43


Compression Facility
Exhaust Stacks
Vents
Return Tanks
03/24/2010 12:28


Compression Facility
Exhaust Vents
03/24/2010 11:42


Disposal Operations
Exhaust
Waste Collection Tank
03/24/2010 12:03

Disposal Operations


Salt Water Disposal Wellhead
Leak at Flange

Flowback Water Waste Pits

Reducing Pollution from Well Completions

- These rules **will reduce pollution** from natural gas wells that are hydraulically fractured**, without slowing production.**
- The rules **phase in requirements for capturing natural gas.** This phase-in provides time for equipment to be manufactured and operators to be trained to capture gas through a process known as a “green completion.”
- Owners/operators of fractured and refractured wells may reduce pollution through flaring until Jan. 1, 2015; after that, gas capture is required.
- Exploratory, delineation and low-pressure wells are exempt from green completion requirements; will have to flare.

Example of Green Completion Equipment (Source: Weatherford)

A natural gas well site. EPA photo.

Greenhouse Gas Reporting

- In November 2010, EPA finalized the reporting requirements for petroleum and natural gas industry, which requires annual reports from large emission sources and fuel suppliers.

- First report was due September 28, 2012 for the calendar year 2011 emissions.

- Rule covers about 85% of the GHG emissions for this sector and includes around 2800 facilities.

- EPA will make the emissions data available by mid February. Published data will be available at: http://ghgdata.epa.gov

Petroleum and Natural Gas Systems in GHGRP (Subpart W)

GHG REPORTING PROGRAM COVERAGE

Production & Processing

1. Drilling and Well Completion
2. Producing Wells
   a. Onshore Wells
   b. Offshore Wells
3. Gas Processing Plant

Natural Gas Transmission & Storage

4. Transmission Compressor Station
5. Transmission Compressor Station
6. Underground NG Storage
7. LNG storage
8. LNG Import-Export Equipment

Distribution

9. Distribution Mains / Services
10. Regulators and Meters

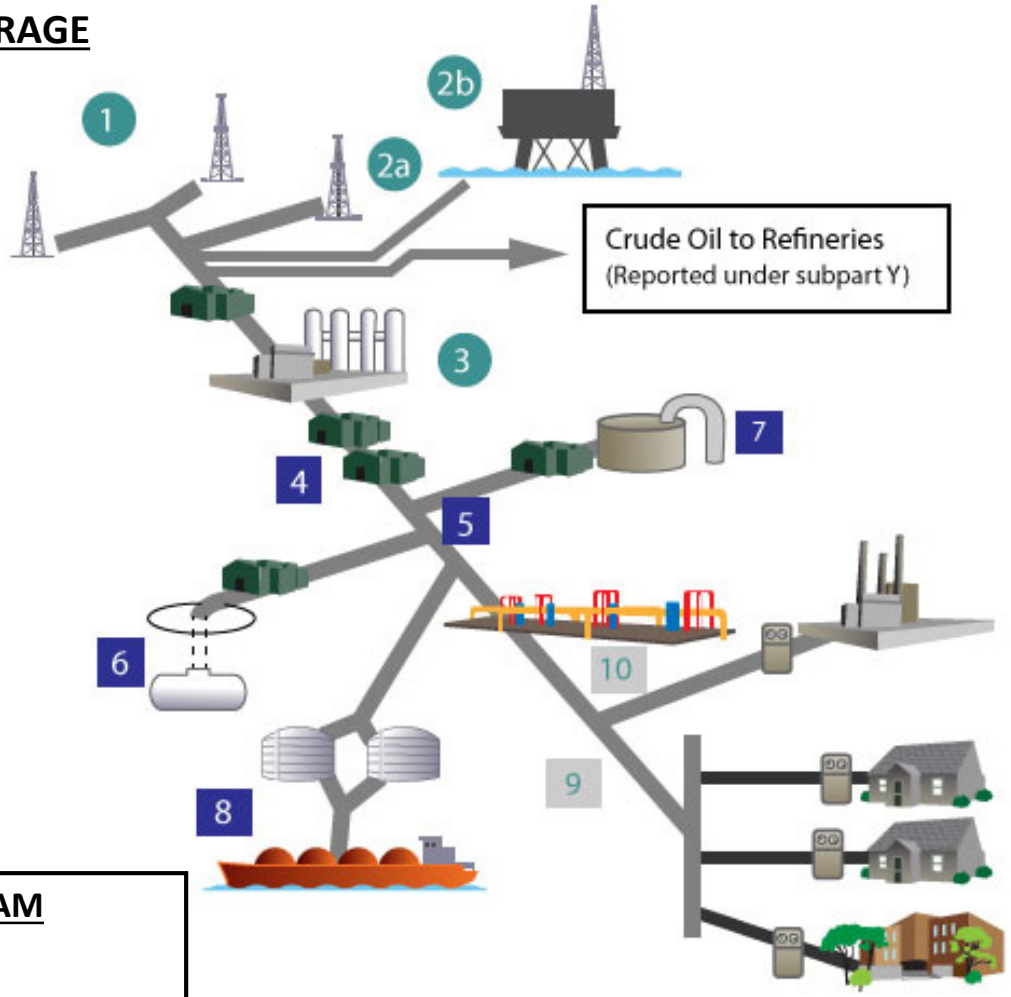
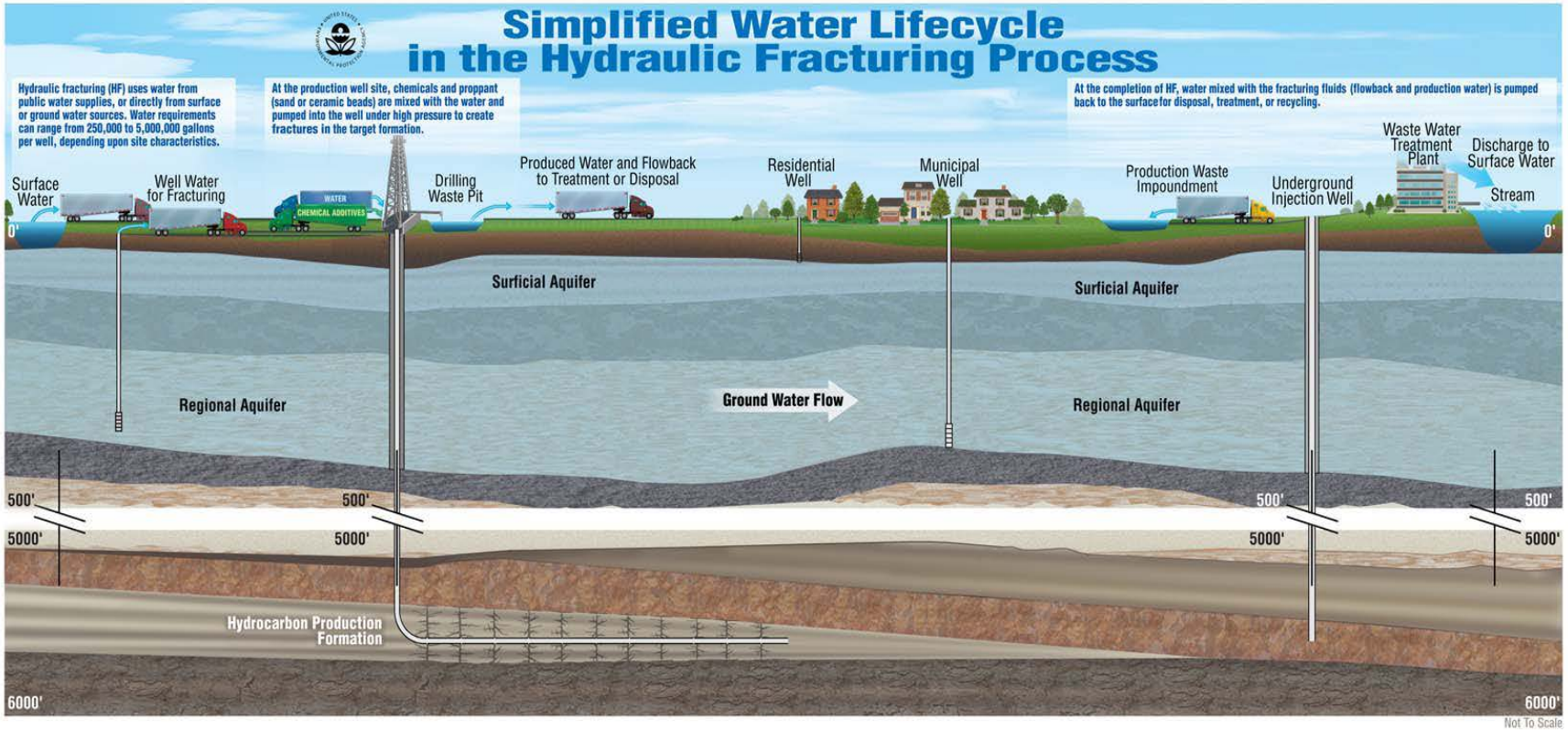


Figure adapted from American Gas Association and EPA Natural Gas STAR Program

NOT COVERED BY GHG REPORTING PROGRAM

- Gathering and boosting
- Oil well vented emissions from hydraulic fracturing
- Facilities below 25,000 mtCO2e reporting threshold

Potential Water Issues



Unconventional Natural Gas Production Impacts

Average horizontal / hydraulically fractured well water usage and production:

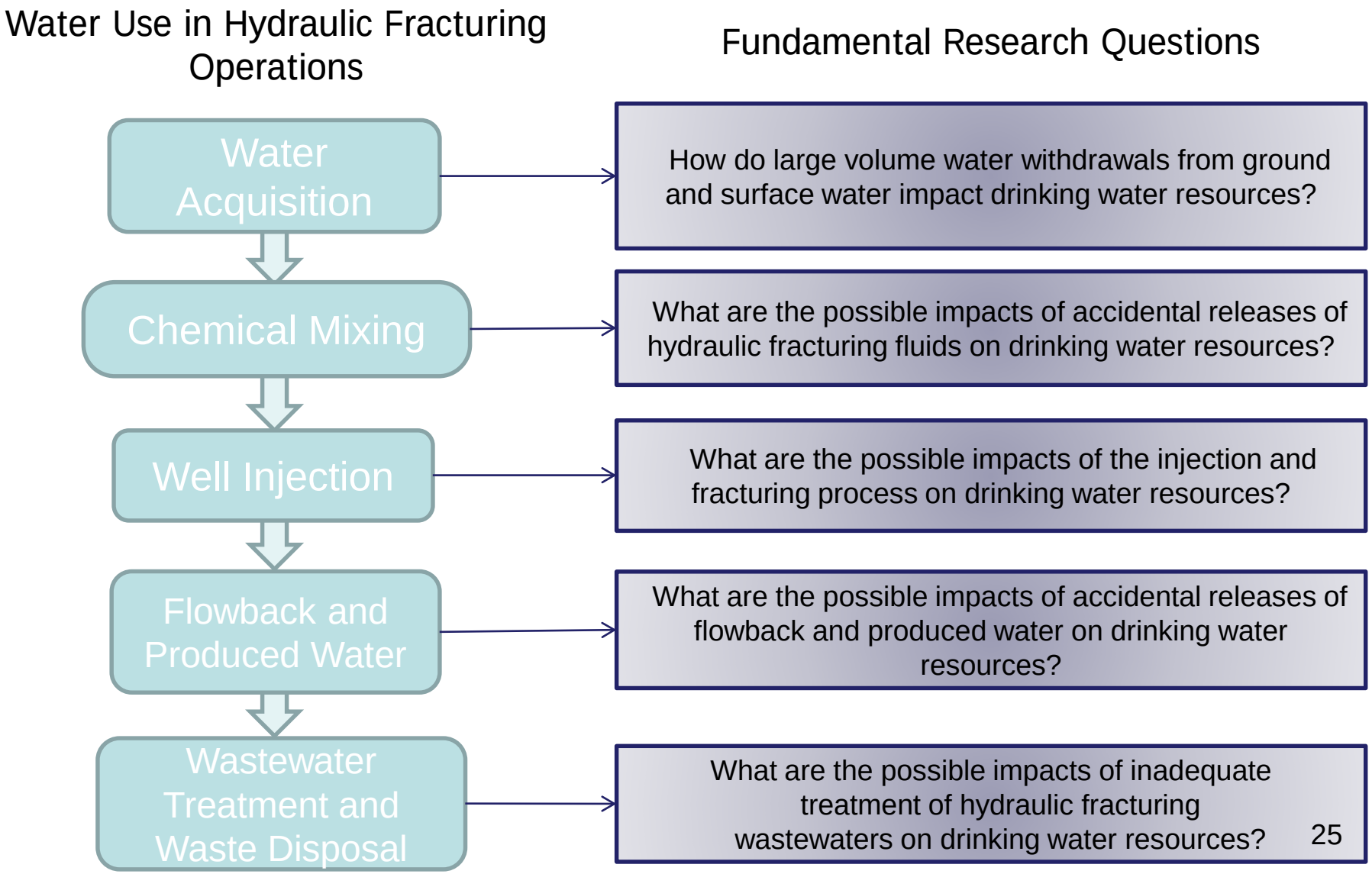
- 5,000,000 gallons of water (not including proppant and/or additive volume)
- Flowback ~60% injected volume (some may be recycled and reused)
- 3,000,000 gallons of produced water to be managed
- Would need 1,000+ trucks to transport waste water to disposal well operations
- Closure of reserve pits and disposal of liners and solids

ORD Hydraulic Fracturing and Drinking Water Study

In its 2010 Appropriations Committee Conference Report, Congress urged EPA to study the relationship between hydraulic fracturing and drinking water, using:

- Best available science
- Independent sources of information
- Transparent, peer-reviewed process
- Consultation with others

Study Follows HF Water Cycle



Study Status Report

- December 21, 2012 EPA released of a study report update
- Describes 18 research projects underway and presents the progress made through September 2012
- Projects are organized according to 5 different types of activities: analysis of existing data, scenario evaluations, laboratory studies, toxicity assessments, and case studies
- www.epa.gov/hfstudy

For more information

- Final Study Plan

  http://water.epa.gov/type/groundwater/uic/class2/hydraulicfracturing/upload/hf_study_plan_110211_final_508.pdf

- US EPA – hydraulic fracturing

  http://www.epa.gov/hydraulicfracture/

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Drilling and production photos provided by the City of Fort Worth